Legume Research

SPRING 1990

CENTER FOR LEGUME RESEARCH / THE UNIVERSITY OF TENNESSEE, KNOXVILLE

THE CENTER FOR LEGUME RESEARCH

US agriculture is in a period of rapid change. Concern with the environment, pressure to reduce production costs, and world competition in commodity values are some of the driving factors. Leguminous crops, because of their high monetary and nutritional value and their ability to be grown without large fertilizer inputs, have the potential of answering many of these concerns. Legumes constitute a key agronomic group that must be exploited more fully if US agriculture is to remain competitive in world markets.

The State of Tennessee is in an ideal position to lead in this development. State agricultural production is heavily committed to legume crops that are grown on over one and one half million acres. State and federally funded legume research at The University of Tennessee has grown rapidly in the past few years and has gained significant international recognition. The enthusiasm of the legume researchers has spread to other groups on the Knoxville campus and has drawn them into basic research on legumes. The result is that a wide range of expertise is now focused on legume biology, and Knoxville has become one of the best places in the nation for a major legume research program.

The Center for Legume Research is dedicated to basic research and the improvement of legumes as crop species. The CLR is further oriented to bringing these results to practice as expeditiously as possible to enhance the Tennessee economy and to improve agricultural productivity throughout the world.

The CLR was formed in 1989 to increase the interdisciplinary interactions of faculty located in several different departments. These researchers realized that the pooling of expertise would result in a synergy that would not only facilitate their own research but would allow more complex problems to be attacked and accelerate the pace toward reaching the ultimate goal of increasing crop productivity and improving world nutrition.

Tennessee agricultural production is heavily committed to legume crops that are grown on over one and one half million acres.

The CLR will focus on three areas: research, education, and technology transfer.

Interdisciplinary research studies include the use of many techniques and a wide variety of expertise. The research ranges from molecular genetics to field studies, including molecular biology, biochemistry, cell biology, microbiology, and plant physiology and breeding. The composite technical and analytical expertise of the Center allows studies using essentially all applicable

(continued on page 2)

GATLINGBURG SYMPOSIA ARE ANNUAL EVENTS

The CLR sponsored the first such symposium on January 8, 1990. It was oriented to discussions of the biochemical and genetic aspects of legume-microbe interactions and was held at the Edgewater Hotel in the resort town of Gatlinburg, just a one-hour drive from Knoxville and at the edge of The Great Smoky Mountains National Park. The sessions were attended by nearly fifty researchers and included 13 talks and 20 posters. Copies of the Program and abstracts can be obtained by sending a $5.00 check or money order (made to the University of Tennessee) to Prof. Dr. Peter M. Gresshoff, Center for Legume Research, 267 PSB, Institute of Agriculture, Knoxville, TN 37901-1071.

The second Symposium is scheduled for January 6-9, 1991. The theme will be "The Biotechnology of Development in Plants and Bacteria" and will be limited to 100 participants. It will bring together researchers from the southeastern region and will feature informal discussisons, oral and poster presentations, and visits to Knoxville laboratories. Special weekend rates are available at the Edgewater Hotel for those arriving on Friday night, and fees will be kept low to encourage graduate-student participation. Weather permitting, recreational activities will be scheduled. Interested persons should contact Dr. Gresshoff at the above address to be placed on the mailing list for announcements.

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

THE CENTER FOR LEGUME RESEARCH

(continued from page 1)

research and evaluative technologies. In addition, new cultivars are being developed, especially in soybean.

The Faculty expect to continue to diversify their research to include a wide variety of legumes. The present research has been specialized toward soybean and, to a lesser extent, alfalfa. The present specialization on soybean will be maintained as a strength in the near term, but studies of other species will certainly increase. The Center also has a continuing commitment to adapt the newest available technologies to agricultural research, and stories on such methods will be included in future issues.

The educational component of the Program is already in place and is being expanded. The several laboratories of the Faculty have numerous graduate students and postdoctoral fellows who are developing their research skills. An informal seminar encompassing all members of the Program has been operating for over a year, and a course in Legume Biology is being offered this semester. In addition, a special educational opportunity is available; a major International Symposium organized by members of the Program is being held in Knoxville this May.

In technology transfer, individual and collaborative activities of the Faculty have resulted in five patent applications and numerous patent disclosures that have been submitted or are presently being developed. In addition, the Program Faculty have developed a broad range of contacts with local, national, and international agricultural corporations and research organizations.

In summary, the breadth of expertise is the strength of the Center. The cooperative activities within the Center will maximize the benefits of pooled research capabilities to enhance the research contributions in the legume field.

INDUSTRIAL AFFILIATES

This activity of the CLR is being developed and will give companies immediate access to the technology developed, the expertise of the Faculty, and certain facilities of the Campus. Member corporations will receive preprints of publications, announcements of and preference for licenses on patents and other property rights, reduced registration fees for CLR Symposia, and certain consulting benefits from the Faculty and staff. This service will also allow member corporations to be kept abreast of developments in the field of legume research in general.

Further information is available from the Director.

FACULTY EXPERTISE AND UNIVERSITY FACILITIES

The Faculty and their research staffs include a broad range of technical and disciplinary knowledge. This group has an established record of close cooperation including joint grants, papers, and patents. For example, the CLR is one of the few national centers with the capability to produce transgenic soybean plants utilizing the newly developed ballistic method of DNA transfer. Likewise, the Faculty constitute one of the leading groups in the study of the nitrogen fixing symbiosis critical to the agronomic value of leguminous crops. The Program is unique in its proven record of integrating such diverse disciplines as molecular genetics, cell biology, and biochemistry.

Numerous research-support facilities of the University are used and can be accessed through the Faculty. For example, extensive use has been made of the state-of-the-art facilities of the biological sciences departments of the College of Liberal Arts. The Analytical Electron Microscopy Facility includes two transmission electron microscopes equiped for analytical functions and two recently acquired high-resolution scanning electron microscopes. The Molecular Biology Resources Facility is equipped and staffed for amino acid and nucleotide sequencing and peptide and nucleic-acid syntheses, and a Monoclonal Antibody Laboratory is available to produce antibodies.

We would be glad to discuss the availability of the Faculty and these facilities with prospective students, university researchers, and industrial corporations.

INTERNATIONAL CONGRESS ON NITROGEN FIXATION

The CLR Faculty, along with a representative of the Tennessee Valley Authority, are hosting the 8th International Congress in Knoxville May 20 to 26, 1990. This Congress focuses World nitrogen fixation research into a single meeting that is typically attended by over 600 scientists from more than 40 countries. Last held in Cologne in the Spring of 1988, that Congress celebrated the 100th anniversary of the publication by Hellreigel and Wilfarth of their classic paper showing that leguminous plants can incorporate atmospheric nitrogen. The Congress in Knoxville has the theme, "Achievements and Objectives of Nitrogen Fixation" and will include invited papers and contributed posters. It will emphasize the impact of modern biological and chemical analysis on the practical

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

applications of nitrogen fixation. Joint sessions of chemists, microbiologists, cell biologists, geneticists, and agronomists will focus on plant development, evolution, industry, agriculture and silviculture, environment and natural resources, and genetic regulation. Our next issue of *Legume Research* will report on some of the papers and talks given in the Congress.

This Congress focuses World nitrogen fixation research into a single meeting that is typically attended by over 600 scientists from more than 40 countries.

FROM THE DIRECTOR'S DESK

These are exciting and provocative times for agricultural scientists. The birth of modern Agricultural Biotechnology is now complete, and the future is bright as these new methods find their way rapidly from the laboratory into the field.

The modern demands on agriculture are forcing a reevaluation of the past yield-driven research activites of the agricultural community. New terms have been added to our jargon, such as "sustainable agriculture," which are having and will continue to have major impacts on the ways in which we do business.

With all of these changes in mind, my colleagues and I at the University of Tennessee have established the Center for Legume Research. It is our contention that Legumes will play a major role in the new developments which are changing agriculture. Leguminous crops are among the most important within the United States and even more so throughout the world. The Center is dedicated to research on legumes directed toward improving their agronomic benefit and also increasing the basic knowledge of their physiology and genetics. Legumes will play an important role in sustainable agriculture due to their ability to grow with limited inputs and improve soil quality.

We are building a group dedicated to the study of legumes in an interdisciplinary and truly interactive way. The Center is not an artificial structure but is a formal designation for a group of faculty who already have numerous interactions, collaborative research projects, and jointly funded research activities. CLR will support and foster further interactions among the members of the group.

Our goals, however, for the Center are far more ambitious than to be oriented only to the scope of the University of Tennessee. We intend for the Center to play an important role in fostering research interest in leguminous plants and increasing interaction and communication among researchers in all the allied fields. One of our first efforts in this regard is sponsoring the 8th International Congress on Nitrogen Fixation. This newsletter represents an additional effort to reach out to the research community, announce our existence, and begin to build lines of communication.

A word about our logo. The CLR logo incorporated in our masthead represents the typical flower cross-section of the plants in the Family Leguminosae. This simple figure reflects the interest of the Center in all species of leguminous plants.

Dr. Gary Stacey

Legume Research

Legume Research is published twice annually for the sponsors, collaborators, staffs, and friends of the Center for Legume Research of the University of Tennessee.

Director: Dr. Gary Stacey
M415 Walters Life Sciences Building
The University of Tennessee
Knoxville, TN 37996-0845

Associate Director:
Dr. Peter M. Gresshoff
267 Ellington Plant Science Building
The University of Tennessee
Knoxville, TN 37901-1071

Associate Director and Newsletter Editor:
Dr. L. Evans Roth
M313 Walters Life Sciences Building
The University of Tennessee
Knoxville, TN 37996-0810

Material in this newsletter may be freely quoted or reproduced, unless otherwise noted. A credit to *Legume Research* will be appreciated.

The University of Tennessee, Knoxville, does not discriminate on the basis of race, sex, color, religion, national origin, age, handicap, or veteran status in provision of educational opportunities or employment opportunities and benefits.

UT Knoxville does not discriminate on the basis of sex or handicap in the education programs and activities which it operates, pursuant to the requirements of Title IX of the Education Amendments of 1972, Public Law 92-318, and Section 504 of the Rehabilitation Act of 1973, Public Law 93-112, respectively. This policy extends both to employment by and admission to the University.

Inquiries concerning Title IX and Section 504 should be directed to the Office of Affirmative Action; 403-C Andy Holt Tower; The University of Tennessee, Knoxville; Knoxville TN 37996-0144; (615) 974-2498. Charges of violation of the above policy should also be directed to the Office of Affirmative Action.

R01-1082-70-001-90

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

ORGANIZATION

The Faculty is composed of a core group, Associate Faculty, and numerous collaborators.

THE CORE FACULTY ARE:

- Dr. Fred L. Allen, Associate Professor, Department of Plant and Soil Science
- Dr. John G. Graveel, Associate Professor, Department of Plant and Soil Science
- Dr. Peter M. Gresshoff, Racheff Chair of Plant Molecular Genetics, Institute of Agriculture
- Dr. Beth C. Mullin, Professor, Department of Botany
- Dr. L. Evans Roth, Professor, Department of Zoology
- Dr. Daniel M. Roberts, Assistant Professor, Department of Biochemistry
- Dr. Gary Stacey, Associate Professor, Department of Microbiology

ADMINISTRATION

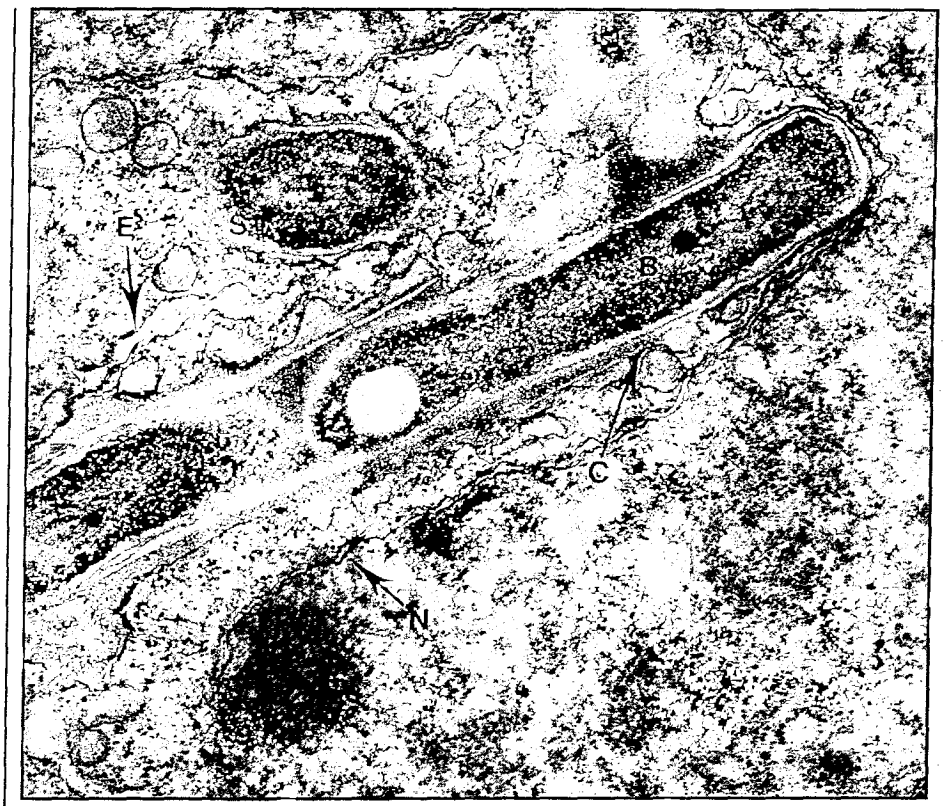
- Dr. Gary Stacey, Director
- Dr. Peter M. Gresshoff, Associate Director
- Dr. L. Evans Roth, Associate Director

The Center is . . . a group of faculty who already have numerous interactions, collaborative research projects, and jointly funded research activities.

GRADUATE COURSE IN LEGUME BIOLOGY

"Legume Biology" is being offered during the Spring semester, 1990, as a doctoral level course under the joint listing of *Special Topics in Plant Breeding* (PSS605) and *Advanced Topics in Life Sciences* (LS610). The Core Faculty members and associates in CLR are presenting lectures on their various areas of expertise pertaining to the activation, development, and regulation of the symbiotic relationship between the plant and the bacteria for nitrogen fixation. Twelve students are enrolled in the course and represent five different disciplines.

Such lectures will be offered each year as a "topics" course.



Bradyrhizobium japonicum *being released into the cytoplasm of a nodule cell in soybean. The bacterium [B] is being released from an infection thread in which the cell wall [C] has become very thin, and new membrane [M] is being formed to enclose the bacterium as it will be contained in a symbiosome [S], the functional unit of nitrogen fixation (Roth et al., 1988). The release process always takes place near the nuclear envelope [N] where an ample supply of endoplasmic reticulum [E] provides new membrane material. Transmission electron micrograph at a magnification of 35,700x. (Roth and Stacey, 1989a.)*

PREDOCTORAL AND POSTDOCTORAL POSITIONS AVAILABLE

Numerous opportunities are available for research experience in the laboratories of the Faculty.

Several students seeking Master's and doctoral degrees are accepted each year, and stipends are available, either as research assistantships funded from the resources of the Faculty and the University or as teaching assistantships in the participating Departments. Degree programs can be chosen in the Plant Physiology and Genetics or Molecular, Cellular, and Developmental Biology tracks of the Life Sciences Graduate Program or in the graduate programs of the several departments.

Postdoctoral appointments are also being filled each year for periods averaging two years. Postdoc-

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

toral Fellows may work with one Faculty member or in a combination of laboratories in the Center; in either case they are able to benefit from the collected activities of the CLR. Competitive stipends are available.

Interested persons should contact the Director.

RESEARCH ACTIVITIES OF THE FACULTY

A. CURRENT RESEARCH SUPPORT

Current research support of the Core Faculty exceeds $1.7 million from competitive sources at state and federal levels.

B. PAST RESEARCH SUPPORT (LAST FIVE YEARS)

In addition to the $1.7 million in present support, the Core Faculty have received from competitive granting sources in excess of $2.7 million in research support in the last five years.

C. PATENT APPLICATIONS

In the last five years, the Core Faculty have filed five patent applications arising from their research. Numerous additional patent disclosures are presently in preparation. Two of the recent patent disclosures have arisen through interdisciplinary cooperative research facilitated by the Legume Research Program.

D. CULTIVAR RELEASES

Two soybean cultivars have been developed from the Soybean Breeding Program at the Tennessee Agricultural Experiment Station.

TN 5-85. This maturity group V cultivar has high yield potential, good seed quality, and shatter resistance. It has resistance to several foliar diseases and to races 1 and 3 of the soybean cyst nematode and the peanut root-knot nematode. It was released in 1985 and certified seed was available to producers in 1988. It is now replacing acreage of cultivars such as Forrest, Bay, York, and Essex.

TN 4-86. This maturity group IV cultivar has high yield potential, excellent seed quality, and shatter resistance, compared to cultivars of similar maturity. It has good lodging resistance and resistance to races 3 and 4 of the soybean cyst nematode and moderate resistance to peanut root-knot nematode. It was released in 1986 and approximately 3300 bushels of Foundation seed were sold to Tennessee seed producers in 1988. It is rapidly becoming one of the most popular early-maturing cultivars in Tennessee.

TN 4-86 soybean cultivar developed by the Tennessee Agricultural Experiment Station.

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

E. CURRENT ACTIVITIES AND RECOGNITIONS

Dr. Fred Allen has been appointed to the National Biological Impact Assessment Program (NBIAP), the mission of which is to facilitate safe field testing of genetically modified organisms. Organized by the US Department of Agriculture, it is part of a national program in biosafety to support biotechnology research in both public and private sectors. He also serves as an Associate Editor of *Crop Science*. He was an invited speaker at the Tennessee Farm Bureau Young Leaders Meeting in 1989; the joint meeting of the Tennesse Crop Improvement Association (on whose Board of Directors he serves), Tennessee Foundation Seeds, Inc., and Tennessee Certified Varieties, Inc. in 1990; and the World Soybean Research Conference IV in Buenos Aires in 1989.

Dr. John Graveel has been appointed by the American Society of Agronomy to chair a committee to study the *Journal of Agronomic Education*, a journal for which he is an Associate Editor. He also serves as the President of the East Tennessee Chapter of the Soil and Water Conservation Society.

Dr. Peter Gresshoff was honored when he received a second doctoral degree, the Doctorate of Science, from the Australian National University on September 29, 1989, for his research on the "Plant Genetic Control of Nodulation in Legumes."

He is also the editor of a book, "The Molecular Biology of Symbiotic Nitrogen Fixation," published this year by the CRC Press, Boca Raton, Florida. He is Co-chairman of the 8th International Congress on Nitrogen Fixation.

Dr. Gresshoff has given invited lectures at the regional meeting of the American Chemical Society, Cincinnati, Ohio; the Adolph Coors Brewery; the Friedrich Mieschen Institute, Basel, Switzerland; the Australian National University, Canberra; the German Academy of Sciences Institute, Greisswald, East Germany; and the Institute of Bioorganic Chemistry, Poznan, Poland.

Dr. Dan Roberts was an invited speaker at a meeting on "Current Topics in Plant Biochemistry and Physiology" held April 4-6, 1990, at the University of Missouri. This year's meeting is devoted to calcium metabolism and regulation, and Dan spoke on his work on the phosphorylation/dephosphorylation of plant proteins and protein kinases.

Dr. Evans Roth is a Co-chairman and the Treasurer of the 8th International Congress on Nitrogen Fixation. He is also the recipient, with Dr. David A. Hake of the UT College of Business Administration, of two contracts from the US Information Agency to host visits of university presidents and scientists from Eastern Europe.

He serves on the Editorial Boards of the *International Review of Cytology* and the *European Journal of Cell Biology*.

Dr. Gary Stacey has been appointed to a Visiting Chair, the van der Klaauw Chair of Biology, at Leiden University in The Netherlands. He will be working there in the Department of Plant Molecular Biology with Dr. Ben Lugtenberg during the Fall semester, 1990.

He was an invited speaker at the NATO Advanced Research Workshop entitled "Molecular Signals in Microbe-Plant Symbiotic and Pathogenic Systems" in May, 1989, in The Netherlands; the 12th North American Symbiotic Nitrogen Fixation Conference in August, 1989, at Ames, Iowa; and the Joint USA-Japan Symposium on Nitrogen Fixation in Soybean in October, 1989, in Davis, California. He is also a Co-chair and Convener for the 8th International Congress on Nitrogen Fixation in May, 1990, in Knoxville and an invited speaker at the 5th International Symposium on Molecular Genetics of Plant-Microbe Interactions in September at Interlaken, Switzerland.

F. PUBLICATIONS

1. Summary. In the last five years, the Core Faculty have published over 160 research papers. In addition to these formal publications, they have contributed many papers and abstracts at scientific meetings and presented numerous invited seminars at national and international institutions and scientific conferences.

2. Publications in the last twelve months

a. Collaborative Papers with other institutions

S.H. Brawley and D.M. Roberts. 1989. Calmodulin-binding proteins are developmentally regulated in gametes and zygotes of fucoid algae. Develop. Biol. 131: 313-320.

D.A. Day, B.J. Carroll, A.C. Delves, and P.M. Gresshoff. 1989. The relationship between autoregulation and nitrate inhibition of nodulation in soybeans. Physiol. Plant. 75: 37-42.

D. Gerhold, G. Stacey, and A. Kondorosi. 1989. Use of a synthetic "Nod Box" probe to identify two nodulation operons in *Rhizobium meliloti*. Plant Mol. Biol. 12: 181-188.

A.P. Hansen, M.B. Peoples, and P.M. Gresshoff. 1989. Nitrogen parititioning during early development of supernodulating soybean (*Glycine max* [L.] Merr.) mutants and their wild-type parent. J. Exp. Bot. (in press).

A.P. Hansen, M.B. Peoples, P.M. Gresshoff, C.A. Atkins, J.S. Pate, and B.J. Carroll. 1989. Growth and symbiotic performance of supernodulating soybean (*Glycine max* [L.] Merr.) mutants during vegetative and reproductive development. J. Exp. Bot. (in press).

M.C. Kilhoffer, D.M. Roberts, A.O. Adibi, D.M. Watterson, and J. Haiech. 1989. Fluorescence characterization of VU-9 calmodulin, an engineered calmodulin with one tryptophan in calcium binding domain III. Biochemistry 28: 6086-6092.

C.G.R. Lawson, P.M. Gresshoff, and B.J. Carroll. 1989. Contribution of plant and bacterial nitrate metabolism to the inhibition of the soybean-*Bradyrhizobium* symbiosis by nitrate. Can. J. Bot. (in press).

A. Mathews, B.J. Carroll, and P.M. Gresshoff. 1989. Development of *Bradyrhizobium* infections in supernodulating and non-nodulating mutants of soybean (*Glycine max* [L.] Merr.). Protoplasma 150: 40-47.

A. Mathews, B.J. Carroll, and P.M. Gresshoff. 1990. The genetic interaction between non-nodulation and supernodulation in soybean: an example of developmental epistasis. Theor. Applied Genetics 78: (in press).

A. Mathews, R.M. Kosslak, C. Sengupta-Gopalan, E.R. Appelbaum, B.J. Carroll, and P.M. Gresshoff. 1989. Soybean (*Glycine max*) non-nodulation and supernodulation mutants have wild type root-exudates. Mol. Plant-Microbe Interactions 2: 283-290.

H. Mayer, J.H. Krauss, T. Urbanik-Sypniewsku, V. Puvanesarajah, G. Stacey, and G. Auling. 1989. Lipid A with 2,3-diamino-2,3-dideoxy-glucose in lipopolysaccharides from slow-growing members of Rhizobiaceae and from *Pseudomonas carboxydovorans*. Arch. Microbiol. 151: 111-116.

A. Nittayajarn, B.C. Mullin, and D.D. Baker. 1990. Screening of pure cultured *Frankia* strains for host specificity by RFLP analysis. Appl. Environ. Microbiol. (in press).

J.E. Olsson, P. Nakao, B.B. Bohlool, and P.M. Gresshoff. 1989. Lack of systemic suppression of nodulation in split root systems of supernodulating soybean (*Glycine max* [L] Merr.) mutants. Plant Physiol. 90: 1347-1352.

b. Other Publications

F.L. Allen. 1989. Breeding for stem canker resistance. **In** A.J. Pascale (ed.), Proc. World Soybean Research Conference IV, Buenos Aires. pp. 1155-1160.

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

S.A. Angermuller and L.A. Sayavedra-Soto. 1990. Rapid visualization of genomic DNA and total RNA in agarose gels. BioTechniques 8: 36-37.

R.A. Bloom, B.C. Mullin, and R.L. Tate, III. 1989. DNA restriction patterns and solution hybridization studies of *Frankia* isolates from *Myrica pennsylvanica*. Appl. Environ. Microbiol. 55: 2155-2160.

G. Caetona-Anolles and P.M. Gresshoff. 1989. Early events leading to nodulation control in legumes. Tenn. Farm & Home Sci. 152: (in press).

J.H. Culpepper, S.A. Angermuller, and L.A. Sayavedra-Soto. 1990. Avoiding woody plant DNA sample loss when loading submarine agarose gels for electrophoresis. BioTechniques 8: 171-172.

N. Deshmane and G. Stacey. 1989. Identification of *Bradyrhizobium nod* genes involved in host specific nodulation. J. Bacteriol. 171: 3324-3330.

D.L. Eskew, J. Kapuya, amd S.K.A. Danso. 1989. Nitrate inhibition of nodulation and nitrogen fixation of supernodulating nitrate-tolerant symbiosis mutants of soybean. Crop Sci.: (in press).

D. Gerhold and G. Stacey. 1990. Recent advances in molecular biology techniques for studying phytosymbiotic microbes. **In** C. Hagedorn and J. Nakas (eds.), Biotechnology of Plant-Microbe Interactions. McGraw-Hill, New York.

J.G. Graveel. 1989. Environmental factors affecting food availability: water, soil, and pesticides. **In** Navigating Nutrition in the 90's—Charting Your Way. Baptist Memorial Health Care Systems, Memphis. pp. 29-35.

J.G. Graveel, J.E. Foss, V.E. Reich, D.L. Coffey, T.W. Banta, J.J. Vorst, and D.C. Wolf. 1990. Faculty developed comprehensive examination for plant and soil science. J. Agron. Ed. 19: (in press).

J.G. Graveel, J.R. Overton, F.F. Bell, H.A. Fribourg, and W.L. Sanders. 1989. Response of corn to soil variation in West Tennessee. J. Prod. Agric. 2: 300-305.

C.R. Graves, S. Melton, and F.L. Allen. 1989. Protein and oil content of soybean varieties. Tenn. Agric. Exp. Station, Research Report 89-23.

P.M. Gresshoff. 1990a. The importance of biological nitrogen fixation to new crop development. New Crops. J. Janick (ed.). (in press).

P.M. Gresshoff. 1990b. Riversand-induced chlorosis (bronzing) and cupping of unifolate and early trifoliate leaves in soybean (*Glycine max* [L.] Merr.). New Zealand J. Crop Hort. Sci. 17: (in press).

P.M. Gresshoff. 1990c. The molecular biology of symbiotic nitrogen fixation. CRC, Boca Raton, Fl. (in press).

P.M. Gresshoff. 1990d. The importance of new plants in biological research. The New Biologist 2: 1-3.

P.M. Gresshoff, B.J. Bassam, L. Sayavedra-Soto, R. McDonnell, S. Angermuller, D. Landau-Ellis, L.J. Schuller, J. Bond, T. Sutherland, P. Joshi, N. Gerahty, and G. Caetano-Anolles. 1989. Molecular analysis of genetic control of nodulation and nitrogen fixation in soybean. World Soybean Research Conference IV, Buenos Aires, Argentina 3: 1257-1262.

P.M. Gresshoff, J.E. Olsson, Z.Z. Li, and G. Caetano-Anolles. 1989. Root-shoot interaction in the control of nodulation of soybean. Cur. Topics in Plant Biochem. Plant Physiol. 8: 125-139.

A.P. Hansen, P.M. Gresshoff, J.S. Pate, and D.A. Day. 1990. Interactions between irradiance levels, nodulation and nitrogenase activity of soybean cv. Bragg and a supernodulating mutant. J. Plant Physiol. (in press).

A.P. Hansen, M.B. Peoples, P.M. Gresshoff, C.A. Atkins, J.S. Pate, and B.J. Carroll. 1989. Growth and symbiotic performance of supernodulating soybean (*Glycine max* (L.) Merr.) mutants during vegetative and reproductive development. J. Exp. Bot. 40: 715-724.

A.P. Hansen, M.B. Peoples, and P.M. Gresshoff. 1990. Nitrogen partitioning during early developemnt of supernodulating soybean (*Glycine max* (L.) Merrill) mutants and their wild-type parents. J. Exp. Bot. (in press).

D. Hatterman and G. Stacey. 1990. Efficient transformation of *Bradyrhizobium japonicum* by electroporation. Appl. Env. Microbiol. (in press).

C.L. Hsu and B.C. Mullin. 1989. Physical characterization of mtDNA from cotton. Plant Mol. Biol. 13: 467-468.

D. Johnson, L.E. Roth, and G. Stacey. 1989. Immunogold localization of the NodC and NodA proteins of *Rhizobium meliloti*. J. Bacteriol. 171: 4583-4588.

B.C. Mullin and C.S. An. 1990. The molecular genetics of *Frankia*. In *The Biology of Frankia and Actinorhizal Plants*, C.R. Schwintzer and J.D. Tjepkema, (Eds.). Academic Press, Orlando, Florida, (in press).

S.H. Oh and D.M. Roberts. 1990. Analysis of posttranslational calmodulin methylation in developing pea plants. Plant Physiol. (in press).

A.I. Ononye, J.G. Graveel, and J.D. Holt. 1989. Kinetic and spectroscopic investigations of the covalent binding of nenzidine to quinones. Environ. Toxicol. Chem. 8: 303-308.

A.I. Ononye, J.G. Graveel, and J.G. Holt. 1989. Kinetic studies of the reactions of benzidine with humic acid. Soil Sci. Soc. Am. J. 53: 981-983.

D.M. Panter and F.L. Allen. 1989. Simulated selection for superior yielding soybean lines in conventional vs. double-crop nursery environments. Crop Sci. 29: 1341-1347.

D.M. Roberts. 1989. The detection of a calcium-activated protein kinase in *Mougeotia* by using synthetic peptide substrates. Plant Physiol. (in press).

L.E. Roth and G. Stacey. 1989a. Bacterium release into host cells of nitrogen fixing soybean nodules: The symbiosome membrane comes from three sources. Eur. J. Cell Biol. 49: 13-23.

L.E. Roth and G. Stacey. 1989b. Cytoplasmic membrane systems involved in bacterium release into soybean nodule cells as studied with *Bradyrhizobium japonicum* mutants. Eur. J. Cell Biol. 49: 24-32.

S.E. Schlarbaum, W.T. Witte, O.J. Schlarbaum, B.C. Mullin, and R.A. Cox. 1989. The same tests with different answers: Nurserymen can benefit from commercial forestry research. American Nurseryman 169: 53-55.

G. Smit and G. Stacey. 1990. Adhesion of bacteria to plant cells: Role of specific interactions versus hydrophobicity. **In** M. Rosenberg and R.J. Doyle (eds.), Microbial Cell Surface Hydrophobicity. ASM Press, Washington, D.C. (in press).

G. Stacey, M.G. Schell, and N. Deshmane. 1989. Determinants of host specificity in the *Bradyrhizobium japonicum*-soybean symbiosis. **In** B. Lugtenberg (ed.), Molecular Signals in Microbe-Plant Symbiotic and Pathogenic Systems. Springer-Verlag, Berlin pp. 395-399.

T.D. Sutherland, B.J. Bassam, L.J. Schuller, and P.M. Gresshoff. 1990. Early nodulation signals in wild-type and symbiotic mutants of soybean (*Glycine max*). Molecular Plant-Microbe Interactions (in press).

W.F. Whitehead and F.L. Allen. 1989. High- versus low-stress yield test nursery environments for selecting superior soybean lines. Crop Sci. (in press).

J.D. Wolt, G.N. Rhodes, Jr., J.G. Graveel, E.M. Glosauer, M.K. Amin, and P.L. Church. 1989. Activity of imazaquin in soil solution as affected by incorporated wheat, Triticum aestivum, straw. Weed Sci. 37: 254-258.

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000

EDUCATIONAL ACTIVITIES OF THE FACULTY

A. SUMMARY OF DEGREES AWARDED IN THE PAST FIVE YEARS UNDER THE SUPERVISION OF CORE FACULTY

Over the past five years, members of the Core Faculty have supervised the awarding of 21 Ph.D. degrees and 12 M.S. degrees. Students leaving the programs have chosen a variety of career avenues, either seeking further educational training or choosing employment in the private, governmental, or academic sectors.

B. PRESENT GRADUATE STUDENTS

Name	Degree Sought	Previous Institution
Linda Besl	Ph.D.	Fredonia State University
James E. Bond	Ph.D.	University of Wales, United Kingdom
Amma P. Bruce	Ph.D.	University of Ghana, Ghana
Delores M. Chandler	M.S.	University of Tennessee
Jong-Yoon Chun	M.S.	Kun Kug University, Korea
John H. Culpepper	M.S.	University of Tennessee
Thomas C. Dockendorff	Ph.D.	North Dakota State University
Roel Funke	M.S.	University of Tennessee
Noel E.A. Gerahty	M.S.	Australian National University
Farshid Ghasemmi	Ph.D.	University of Tehran, Iran
Paula Goetting-Minesky	Ph.D.	Washington University
Wickson T. Kawanga	M.S.	University of Malawi, Malawi
G. Alan Lowman	M.S.	Tennessee Technical University
Sohail S. Luka	Ph.D.	Ain Shams University, Egypt
Suk-Heung Oh	Ph.D.	Chonbuk National University, Korea
Aloysius Ononye	Ph.D.	University of Western Ontario
Fatimata Pale	Ph.D.	University of Bordeaux, France
Donald M. Panter	Ph.D.	University of Tennessee
Rekha R. Prabhu	Ph.D.	University of Tennessee
Daqi Qian	Ph.D.	Nanjing Agricultural University, Peoples' Republic of China
Gerry L. Sexton	M.S.	University of Tennessee
Gafur Sutaerman	M.S.	Tanjingpura University, Indonesia
Susan M. Swenson	Ph.D.	Grinnell College
Paul G. Twigg	Ph.D.	Indiana University of Pennsylvania
C. David Weaver	Ph.D.	University of Tennessee

C. PRESENT POSTDOCTORAL ASSOCIATES (WITH PREVIOUS INSTITUTIONS)

W. Mark Barbour	North Carolina State University
Brent J. Bassam	Australian National University
Helen Belefant	Texas A&M University
Gustavo Caetano-Anolles	Ohio State University
David L. Eskew	International Atomic Energy Agency, Vienna
Dennis R. Hattermann	University of Illinois
Priyavadan Joshi	University of Tennessee
L. Sayavedra-Soto	Oregon State University
Arun J. Sharma	University of Baroda, India
Gerrit Smit	University of Leiden, The Netherlands
Shui-Ping Wang	Shanghai Institute of Plant Physiology

D. VISITING SCIENTISTS, 1987-1990

Dr. Chung Sun An	Seoul National University, Korea
Dr. Martha Beyazova	Institute of Microbiology, Bulgaria
Dr. Zhi Zheng Li	Plant Physiology Institute, Peoples' Republic of China
Dr. Aphakorn Nittajarn	Resource Center for South and Southeastern Asia, Thailand
Dr. Maria Valdes	Escuela National Ciencias Biologicas, Mexico
Dr. Alvero A.T. Vargas	Centro de Energia Nuclear na Agricultura, Brazil

Center for Legume Research
M415 Walters Life Sciences Building
The University of Tennessee, Knoxville
Knoxville, TN 37996-0845

Source: https://www.industrydocuments.ucsf.edu/docs/ngvc0000